TERMINAL LEARNING OBJECTIVE

ACTION

Compute mathematical operations in the binary, octal, and hexadecimal numbering systems.

CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, and official OMEMS reference material.

STANDARD

Correctly answer 18 of 25 questions concerning mathematical operations in the binary, octal, and hexadecimal numbering systems.

CLASSIFICATION:	UNCLASSFIED
SAFETY CONSIDERATIONS:	ELECTRICAL SHOCK HAZARD
	ELECTOSTATIC DISCHARGE
ENVIRONMENTAL:	NONE
RISK ASSESMENT:	LOW

ENABLING LEARNING OBJECTIVE 1

ACTION

Explain mathematical operations in the decimal numbering system.

CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, and official OMEMS reference material.

STANDARD

Correctly answer 18 of 25 questions concerning mathematical operations in the binary, octal, and hexadecimal numbering systems

$246._{(10)}$

MSD
LSD
PLACE
HOLDER
RADIX
RADIX POINT

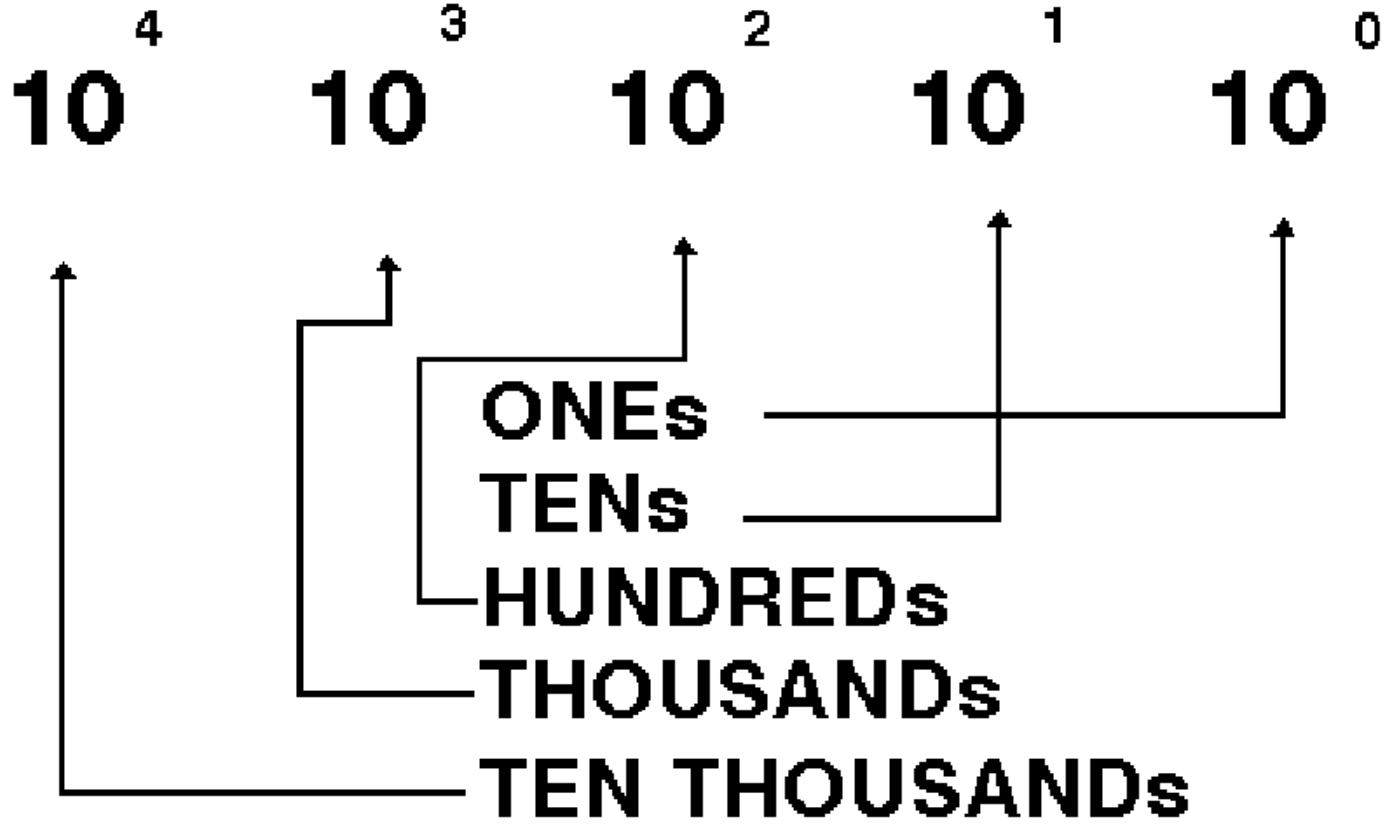
HAM

NUMBER SYSTEM TERMS

EL03-S02

DECIMAL SYSTEM COUNTING

0	1	2	3	4	5	6	7	8	9
+1	+1	+1	+1	+1	+1	+1	+1	+1	+1
1	2	3	4	5	6	7	8	9	10



DECIMAL POSITIONAL NOTATION

EL03-S04

The Most Significant Digit is the number

1. farthest to the left.
2. farthest to the right.

The Most Significant Digit is the number

1. farthest to the left.
2. farthest to the right.

ENABLING LEARNING OBJECTIVE 2

ACTION

Compute mathematical operations in the binary numbering system.

CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, and official OMEMS reference material.

STANDARD

Correctly answer 18 of 25 questions concerning mathematical operations in the binary, octal, and hexadecimal numbering systems.

BINARY NUMBER SYSTEM

$N_{(2)}$

0 1

COUNTING

0,1,↓10,11,↓100, 101,
110,111,↓1000, ...

BREAKPOINTS ARE INDICATED BY ARROWS

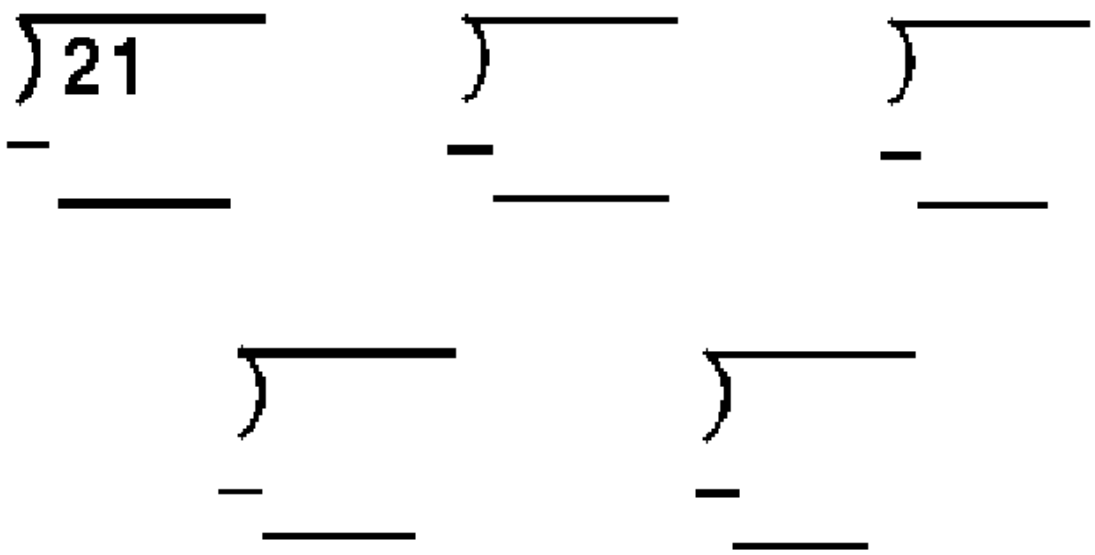
POSITIONAL NOTATION DIAGRAM

POSITION OF DIGIT	10	9	8	7	6	5	4	3	2	1
POWERS OF TWO	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
DECIMAL VALUE	512	256	128	64	32	16	8	4	2	1

21 DECIMAL = BINARY

1. $2^0 = 1$
   $2^1 = 2$
   $2^2 = 4$
   $2^3 = 8$
   $2^4 = 16$
   $2^5 = 32$

2. $)21$



BASE 10 TO BINARY CONVERSION

RULES OF ADDITION

0	0	1	1
+ 0	+ 1	+ 0	+ 1
0	1	1	10

RULES OF SUBTRACTION

0	1	1	0
- 0	- 0	- 1	- 1
0	1	0	X

RULES OF MULTIPLICATION

0	1	0	1
X 0	X 0	X 1	X 1
0	0	0	1

BINARY DIVISION

ONE'S COMPLEMENT

GIVEN: 110010

$$\begin{array}{r} 111111 \\ -\ 110010 \\ \hline 001101 \end{array}$$

OR

INVERT EACH DIGIT

TWO'S COMPLEMENT

[ADD 1 TO THE ONE'S COMPLEMENT]

GIVEN	=	110010
ONE'S COMPLEMENT	=	001101
TWO'S COMPLEMENT	=	+ 1
		001110

OR

INVERT ALL DIGITS TO THE LEFT OF THE LEAST SIGNIFICANT ONE

What is the highest admissible mark in binary?

1. 0
2. 1
3. 7
4. 9

What is the highest admissible mark in binary?

1. 0
2. 1
3. 7
4. 9

EL03-S48

Subtract the following Binary numbers.

(1001-111)

1. 1
2. 0
3. 10
4. 11

EL03-S30

Subtract the following Binary numbers.

(1001-111)

1. 1
2. 0
3. 10
4. 11

EL03-S30

Convert decimal number 21 to binary.

1. 10101
2. 11001
3. 10001
4. 11110

EL03-S32

Convert decimal number 21 to binary.

1. 10101
2. 11001
3. 10001
4. 11110

EL03-S32

What is the 2's complement of 1111?

1. 0001
2. 0010
3. 10000
4. 11000

EL03-35

What is the 2's complement of 1111?

1. 0001
2. 0010
3. 10000
4. 11000

EL03-35

ENABLING LEARNING OBJECTIVE 3

ACTION

Compute mathematical operations in the octal numbe system.

CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, and official OME reference material.

STANDARD

Correctly answer 18 of 25 questions concerning mathematical operations in the binary, octal, a

hexadecimal numbering systems.

OCTAL SYSTEM COUNTING

0	1	2	3	4	5	6	7
+1	+1	+1	+1	+1	+1	+1	+1
1	2	3	4	5	6	7	10

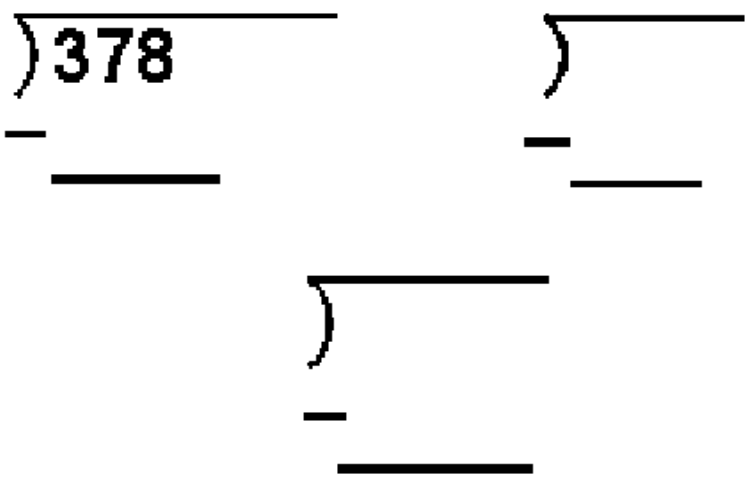
POSITIONAL NOTATION DIAGRAM

POSITION OF DIGIT	6	5	4	3	2	1
OCTAL POSITION	8^5	8^4	8^3	8^2	8^1	8^0
DECIMAL VALUE	32768	4096	512	64	8	1

378 DECIMAL = OCTAL

1. $8^0 = 1$
   $8^1 = 8$
   $8^2 = 64$
   $8^3 = 512$
   $8^4 = 4096$
   $8^5 = 32768$

2.



BASE 10 TO OCTAL CONVERSION

EL03-S16

BINARY TO OCTAL CONVERSION

[DIVIDE THE BINARY NUMBER INTO GROUPS OF THREE]

4 2 1	4 2 1	4 2 1	4 2 1
1 1 0	0 0 1	1 0 1	1 0 0

OCTAL TO BINARY CONVERSION

[CONVERT EACH DIGIT INTO BINARY GROUPS OF THREE]

1	7	2	3
4 2 1	4 2 1	4 2 1	4 2 1

OCTAL
ADDITION - SUBTRACTION

0	1	2	3	4	5	6	7
1	2	3	4	5	6	7	10
2	3	4	5	6	7	10	11
3	4	5	6	7	10	11	12
4	5	6	7	10	11	12	13
5	6	7	10	11	12	13	14
6	7	10	11	12	13	14	15
7	10	11	12	13	14	15	16

5243
+2267

OCTAL
ADDITION - SUBTRACTION

5243
−2267

0	1	2	3	4	5	6	7
1	2	3	4	5	6	7	10
2	3	4	5	6	7	10	11
3	4	5	6	7	10	11	12
4	5	6	7	10	11	12	13
5	6	7	10	11	12	13	14
6	7	10	11	12	13	14	15
7	10	11	12	13	14	15	16

OCTAL
MULTIPLICATION - DIVISION

$$\begin{array}{r} 56 \\ \times\ 7 \\ \hline \end{array}$$

0	1	2	3	4	5	6	7
1	1	2	3	4	5	6	7
2	2	4	6	10	12	14	16
3	3	6	11	14	17	22	25
4	4	10	14	20	24	30	34
5	5	12	17	24	31	36	43
6	6	14	22	30	36	44	52
7	7	16	25	34	43	52	61

OCTAL
MULTIPLICATION - DIVISION

$6\overline{)372}$

0	1	2	3	4	5	6	7
1	1	2	3	4	5	6	7
2	2	4	6	10	12	14	16
3	3	6	11	14	17	22	25
4	4	10	14	20	24	30	34
5	5	12	17	24	31	36	43
6	6	14	22	30	36	44	52
7	7	16	25	34	43	52	61

One_____digit is equal to three_____ digits.

1. Hexadecimal, octal
2. decimal, binary
3. Octal, binary
4. hexadecimal, binary

EL03-S31

One_____digit is equal to three_____ digits.

1. Hexadecimal, octal
2. decimal, binary
3. Octal, binary
4. hexadecimal, binary

EL03-S31

Which number system has a radix of eight?

1. Decimal
2. Octal
3. Hexadecimal
4. Binary

Which number system has a radix of eight?

1. Decimal
2. Octal
3. Hexadecimal
4. Binary

EL03-S50

You are using the Octal number system. If you had the number 777 and added one to it, what would be your total?

1. 7771
2. 1000
3. 1777
4. 7000

You are using the Octal number system. If you had the number 777 and added one to it, what would be your total?

1. 7771
2. 1000
3. 1777
4. 7000

Which number has a radix of eight?

1. Binary
2. Octal
3. Decimal
4. Hexadecimal

Which number has a radix of eight?

1. Binary
2. Octal
3. Decimal
4. Hexadecimal

EL03-29

ENABLING LEARNING OBJECTIVE 4

ACTION

Compute mathematical operations in the hexadecimal numbering system.

CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, and official OMEMS reference material.

STANDARD

Correctly answer 18 of 25 questions concerning mathematical operations in the binary, octal, and hexadecimal numbering systems.

HEXADECIMAL SYSTEM COUNTING

0	1	2		A	B	C	D	E	F
+1	+1	+1	...	+1	+1	+1	+1	+1	+1
1	2	3		B	C	D	E	F	10

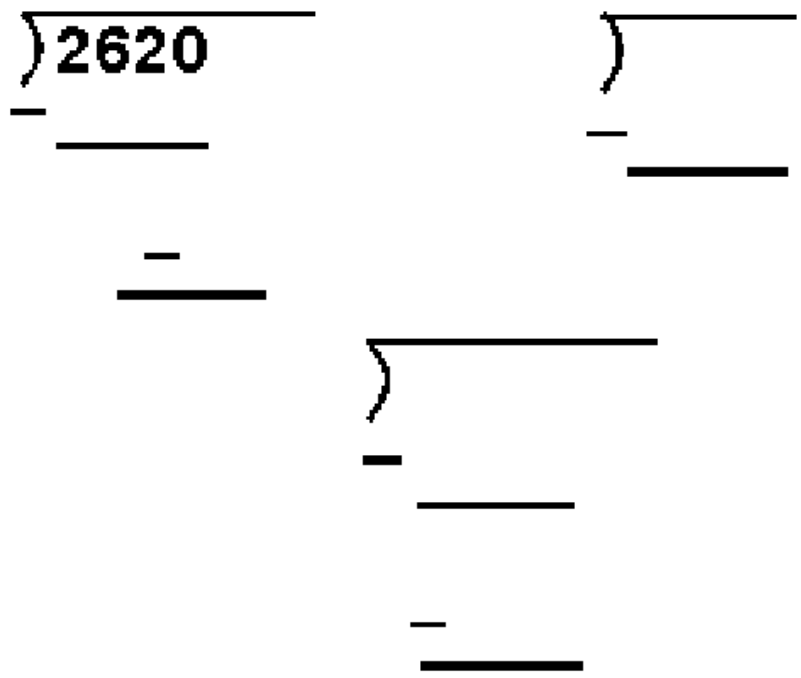
POSITIONAL NOTATION DIAGRAM

POSITION OF DIGIT	5	4	3	2	1
HEXADECIMAL POSITION	16^4	16^3	16^2	16^1	16^0
DECIMAL VALUE	65536	4096	256	16	1

2620 DECIMAL = ____ HEX

1. $16^0 = 1$
   $16^1 = 16$
   $16^2 = 256$
   $16^3 = 4096$
   $16^4 = 65536$

2.



BASE 10 TO HEX CONVERSION

EL03-S22

BINARY TO HEXADECIMAL CONVERSION

[DIVIDE THE BINARY NUMBER INTO GROUPS OF FOUR]

8 4 2 1	8 4 2 1	8 4 2 1	8 4 2 1
1 1 1 0	1 1 1 1	0 1 0 1	0 1 0 0

HEXADECIMAL TO BINARY CONVERSION

[CONVERT EACH DIGIT INTO BINARY GROUPS OF FOUR]

7	B	C	1
8 4 2 1	8 4 2 1	8 4 2 1	8 4 2 1

$$\begin{array}{r} 1\ B\ 2 \\ +F\ 9\ 8 \\ \hline \end{array}$$

HEXADECIMAL ADD - SUB MATRIX

	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	10
2	3	4	5	6	7	8	9	A	B	C	D	E	F	10	11
3	4	5	6	7	8	9	A	B	C	D	E	F	10	11	12
4	5	6	7	8	9	A	B	C	D	E	F	10	11	12	13
5	6	7	8	9	A	B	C	D	E	F	10	11	12	13	14
6	7	8	9	A	B	C	D	E	F	10	11	12	13	14	15
7	8	9	A	B	C	D	E	F	10	11	12	13	14	15	16
8	9	A	B	C	D	E	F	10	11	12	13	14	15	16	17
9	A	B	C	D	E	F	10	11	12	13	14	15	16	17	18
A	B	C	D	E	F	10	11	12	13	14	15	16	17	18	19
B	C	D	E	F	10	11	12	13	14	15	16	17	18	19	1A
C	D	E	F	10	11	12	13	14	15	16	17	18	19	1A	1B
D	E	F	10	11	12	13	14	15	16	17	18	19	1A	1B	1C
E	F	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D
F	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E

F346

- E27E

EL03-S24

HEXADECIMAL ADD - SUB MATRIX

	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	10
2	3	4	5	6	7	8	9	A	B	C	D	E	F	10	11
3	4	5	6	7	8	9	A	B	C	D	E	F	10	11	12
4	5	6	7	8	9	A	B	C	D	E	F	10	11	12	13
5	6	7	8	9	A	B	C	D	E	F	10	11	12	13	14
6	7	8	9	A	B	C	D	E	F	10	11	12	13	14	15
7	8	9	A	B	C	D	E	F	10	11	12	13	14	15	16
8	9	A	B	C	D	E	F	10	11	12	13	14	15	16	17
9	A	B	C	D	E	F	10	11	12	13	14	15	16	17	18
A	B	C	D	E	F	10	11	12	13	14	15	16	17	18	19
B	C	D	E	F	10	11	12	13	14	15	16	17	18	19	1A
C	D	E	F	10	11	12	13	14	15	16	17	18	19	1A	1B
D	E	F	10	11	12	13	14	15	16	17	18	19	1A	1B	1C
E	F	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D
F	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E

HEXADECIMAL MULTIPLICATION -

DIVISION MATRIX

	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
1	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
2	2	4	6	8	A	C	E	10	12	14	16	18	1A	1C	1E
3	3	6	9	C	F	12	15	18	1B	1E	21	24	27	2A	2D
4	4	8	C	10	14	18	1C	20	24	28	2C	30	34	38	3C
5	5	A	F	14	19	1E	23	28	2D	32	37	3C	41	46	4B
6	6	C	12	18	1E	24	2A	30	36	3C	42	48	4E	54	5A
7	7	E	15	1C	23	2A	31	38	3F	46	4D	54	5B	62	69
8	8	10	18	20	28	30	38	40	48	50	58	60	68	70	78
9	9	12	1B	24	2D	36	3F	48	51	5A	63	6C	75	7E	87
A	A	14	1E	28	32	3C	46	50	5A	64	6E	78	82	8C	96
B	B	16	21	2C	37	42	4D	58	63	6E	79	84	8F	9A	A5
C	C	18	24	30	3C	48	54	60	6C	78	84	90	9C	A8	B4
D	D	1A	27	34	41	4E	5B	68	75	82	8F	9C	A9	B6	C3
E	E	1C	2A	38	46	54	62	70	7E	8C	9A	A8	B6	C4	D2
F	F	1E	2D	3C	4B	5A	69	78	87	96	A5	B4	C3	D2	E1

```
  4CE
X   E
-----
```

HEXADECIMAL MULTIPLICATION -

DIVISION MATRIX

$$4\overline{)1\,B\,6}$$

	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
1	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
2	2	4	6	8	A	C	E	10	12	14	16	18	1A	1C	1E
3	3	6	9	C	F	12	15	18	1B	1E	21	24	27	2A	2D
4	4	8	C	10	14	18	1C	20	24	28	2C	30	34	38	3C
5	5	A	F	14	19	1E	23	28	2D	32	37	3C	41	46	4B
6	6	C	12	18	1E	24	2A	30	36	3C	42	48	4E	54	5A
7	7	E	15	1C	23	2A	31	38	3F	46	4D	54	5B	62	69
8	8	10	18	20	28	30	38	40	48	50	58	60	68	70	78
9	9	12	1B	24	2D	36	3F	48	51	5A	63	6C	75	7E	87
A	A	14	1E	28	32	3C	46	50	5A	64	6E	78	82	8C	96
B	B	16	21	2C	37	42	4D	58	63	6E	79	84	8F	9A	A5
C	C	18	24	30	3C	48	54	60	6C	78	84	90	9C	A8	B4
D	D	1A	27	34	41	4E	5B	68	75	82	8F	9C	A9	B6	C3
E	E	1C	2A	38	46	54	62	70	7E	8C	9A	A8	B6	C4	D2
F	F	1E	2D	3C	4B	5A	69	78	87	96	A5	B4	C3	D2	E1

What is the highest admissible mark in the hexadecimal number system?

1. 1
2. 7
3. 9
4. F

What is the highest admissible mark in the hexadecimal number system?

1. 1
2. 7
3. 9
4. F

What are the most common number systems in use today.

1. **Binary, octal, decimal, duodecimal**

2. **Binary, octal, duodecimal, hexadecimal**

3. **Decimal, hexadecimal, duodecimal, octal**

4. **Binary, octal, hexadecimal, decimal**

What are the most common number systems in use today.

1. **Binary, octal, decimal, duodecimal**

2. **Binary, octal, duodecimal, hexadecimal**

3. **Decimal, hexadecimal, duodecimal, octal**

4. **Binary, octal, hexadecimal, decimal**

Which of the following numbers is hexadecimal?

1. 1FG
2. 23H
3. 21F
4. 976K

EL03-S27

Which of the following numbers is hexadecimal?

1. 1FG
2. 23H
3. 21F
4. 976K

EL03-S27

You are using the hexadecimal number system. If you had the number FFF and added one to it, what would be your total?

1. FFF1
2. 1000
3. 1FFF
4. F000

EL03-S28

You are using the hexadecimal number system. If you had the number FFF and added one to it, what would be your total?

1. FFF1
2. 1000
3. 1FFF
4. F000

EL03-S28

Convert hexadecimal number 2222 to binary.

1. 1011011011101010
2. 10001000100010
3. 11011011011010
4. 100100100100010

EL03-S33

Convert hexadecimal number 2222 to binary.

1. 1011011011101010
2. 1000100010010
3. 1101101101010
4. 1001001001010

EL03-S33

What is the MSD in the number 34FE?

1. F
2. E
3. 4
4. 3

EL03-S34

What is the MSD in the number 34FE?

1. F
2. E
3. 4
4. 3

EL03-S34